

E1 Is the Digital Circuit Designer Dead?

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The future of the digital designer is in grave doubt. Technology scaling trends, such as reduced voltage headroom over V_t and exponentially increasing leakage, have often been said to prophesize the death of dynamic logic, cascode circuits, and essentially every logic style that brings excitement to the role of the digital circuit designer. Is this prophesy of doom a falsehood? If not, can job fulfillment otherwise be found in designing only with static logic circuits? Furthermore, industry CAD tools have continuously sought to improve their design capabilities in static logic, for both synthesis and place & route, and thus, there is arguably no need for the expert digital circuit designer at all! This panel will discuss the future role, if any, of the digital designer in light of these compressive forces:

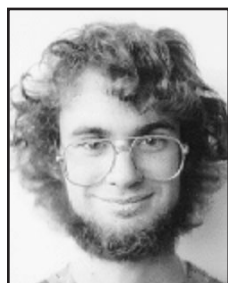
- Does life truly still exist in dynamic and cascode logic, etc.?
- Is the prophesy of doom flat out wrong, or merely forestalled?
- Are those who design dynamic logic structures merely fooling themselves about the benefits, or can they really still deliver their bang for the buck?
- If some few expert circuit designers are in fact still needed, what becomes of the greater majority of those who are not?
- Will new and emerging technologies provide scope for the evolution of the digital species, or will they devolve into button-pushing ASIC monkeys?
- Is it beyond the scope of CAD tools to generate sufficiently fast/low-power circuits, or is the digital circuit designer dead?

Panelists Statements



Jon Beecroft, Quadrics, Bristol, United Kingdom

The digital circuit designer's future is secure although I would happily agree that changing the technology would necessitate new design techniques. The space for dynamic and cascode logic is, perhaps, rapidly disappearing but new techniques to reduce power and improve performance will be invented by the best designers. I would argue that job satisfaction is derived from being part of a successful, profitable, chip design and not by creating exotic circuits that are difficult to test and verify in all process and environmental corners. There are many circuit structures that will always require very careful design; for example PLLs, RAMs, ADCs and DACs. The ever-increasing demands of I/O bandwidth will require the very best talent to be stretched to the limit. The future lies with high frequency serial I/O. CAD tools will continue to improve and simplify the management of designs but this will just encourage more complexity.



David Money Harris, Harvey Mudd College, Claremont, CA

In the 90's, people asked if analog design was dead. Now, they ask if digital design is dead. Rumors of the designer's demise are greatly exaggerated. The digital designer will continue to solve important problems in the area of memory, I/O, clocking, interconnect, and overall system design. However, the importance of alternative circuit families will continue to dwindle. Benefits of pass transistor logic have nearly vanished as V_{DD}/V_t dropped. I have long been an advocate of domino logic. It has an advantage of lower input capacitance per unit drive that is independent of process generation. Unfortunately, the relative advantage of domino to static will gradually diminish as V_t and V_{DD}/V_t continue to drop because of larger keepers and less benefit from skewed switching points. This shrinking advantage, combined with the severe penalties of power and productivity, will relegate domino to very specialized applications.



Mark Horowitz, Stanford University, Stanford, CA

The death of dynamic logic has been greatly overstated. Leakage is a false issue, it is margins that make these circuits difficult. Dynamic circuit will survive, but only in circuit blocks that are "worth" the cost of the NRE and the power (power efficiency is everything today). The real issue is that CMOS circuit design is pretty well mined for speed and power, so we are starting to use the same tricks over and over, and polishing them more. I also don't see a technology that will displace CMOS, so it is unlikely that a technology change will spark new circuit innovation. Rather the innovation is now in applying circuits to do clever functions (like voltage control) rather than the circuits themselves, and in embedding circuit knowledge into CAD tools to decrease the NRE cost and risk of using some advanced circuit styles. Finally many circuit designers will be kept busy trying to figure out how to get anything to work with the leaky, uncontrolled transistors in the 65nm and below technologies.



Robert Montoye, IBM, Austin, TX

Has circuit design ceased to be a differentiator? Not if we are willing to explore new alternatives with different compromises. Using LSDL (limited switch Dynamic Logic) and 8T SRAM, the power supply can be lowered by .25v at the same frequency as good static design with several advantages:

- Total power drops dramatically
- As leakage power drops faster than active, it becomes less of a problem.
- Device design becomes easier with lower field strength.

However, these circuits have their own compromises. 8T SRAM disallows column select, but provides an extra port. LSDL is edge triggered, requiring better clock design, and uses nfet inputs, requiring more careful noise control. Continuing scaling has always brought on a new set of design compromises. The LSDL/8T SRAM compromise can give us another generation of scaling and maybe more. Learning to live with these new design compromises is a better alternative than waiting for the slow death of "safe static," watching the technology commoditize until there is no profit to explore these innovations. Circuit designers are not dead yet, but to survive we need explore the new world of circuit families with acceptable performance at lower voltages.



Gary C. Moyer, Intel, Hudson, MA

Digital circuit designers will continue using complex constructs such as dynamic gates and cascade structures, but use of these circuits will be extremely rare. As technology has scaled, the advantages of many complex circuits over combinational logic have decreased in magnitude, and the disadvantages of these circuits have increased dramatically. Shrinking noise margins and increases in device leakage (departures from the ideal) have caused many new constraints on the design of complex circuits. Migration of these circuits to newer technologies is sometimes not feasible. The need for electrical robustness with respect to process variability is more important than the diminishing performance advantage of the risky complex circuits. For these reasons the future of digital circuit design will be dominated by tool generated combinational logic.



Mike Seningen, Intrinsity, Austin, TX

And I looked, and behold a pale horse and his name that sat upon him was synthesis and place-and-route followed with him. For many years, the prophets have been predicting the demise of the digital circuit designer in favor of automated solutions, yet, the four horsemen of the designer's apocalypse have not appeared. While there have been many advances in mainstream CAD software for logic design, there are still places where those tools have not gone. The digital circuit designer is there to fill the need. Furthermore, the recent advances in process technology vividly demonstrate that all logic families need to be re-imagined to work within the new constraints. With some solid engineering, domino logic is still going strong at 90nm and below, and while some logic families may ultimately pass away, the digital circuit engineer will prevail via innovation and perseverance. The rumors of Armageddon have been greatly exaggerated.



Kazuo Yano, Hitachi, Tokyo, Japan

People have to create value through work. No work without value should remain. The era of making high-performance chips with crafted circuits, such as domino logic, has finished. There are three options for digital designers: joining the SRAM designers who are busy with variability, or joining analog-design community, which is to be value creator in ubiquitous/sensor-network world, or stop touching directly circuits by coaching CAD users with circuit expertise.